SOIL SURVEY OF THE INDIAN RIVER AREA, FLORIDA.

By CHARLES N. MOONEY and MARK BALDWIN.

DESCRIPTION OF THE AREA.

The Indian River area is situated along the middle east coast of the Florida Peninsula. It comprises a narrow coastal strip (a long barrier island), the broad inner island (Merritts Island) in the northern part, and a narrow strip of the mainland which is separated from the islands by sounds. The mainland strip, following the main highway and the Florida East Coast Railway, extends back from the shore line about a mile, except where the railroad and the highway make a detour to get narrower crossing places on streams, in which cases the survey has followed and the breadth is consequently much greater. The barrier island consists of a narrow and low coastal ridge, varying in width over most of its length from 200 yards to 2 miles. In the vicinity of Cape Canaveral in the northern part of the area a width of 4 miles is attained. Merritts Island, south of Banana Creek, is a large cone-shaped island with a maximum width of about 7 miles.

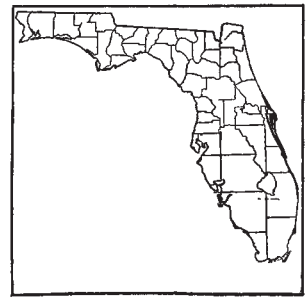

FIG. 17.—Sketch map showing location of the Indian River area, Florida.

The survey includes parts of three counties, passing through Palm Beach County from 3 miles below West Palm Beach north across the whole coastal strip of St. Lucie County northward into Brevard County as far as Titusville, a distance between 140 and 150 miles (149 miles by the Florida East Coast Railway). The area comprises, including tracts of Swamp and grassy ponds but not open bodies of water, 341 square miles, or 218,240 acres.

For the survey the hydrographic charts of the United States Coast and Geodetic Survey were used. A traverse was made of the highways, locating the railroad, streams, and houses along the roads, and in its progress the soil boundaries were defined.

The surface features of the area range from low coastal swamps and level flatwoods to dunelike coastal ridges. The range in elevation is from tide level to 60 or 70 feet, this maximum occurring on the crests of the higher dunelike hills.

The barrier island along the coast consists of a number of low parallel ridges with intervening troughs, the ridge next the ocean being highest and the others gradually becoming lower inland to the sounds, low marginal mangrove swamps, or flat salt marshes. The elevation of the coastal ridges next the ocean probably averages between 15 and 20 feet above sea level.

At a few points, as at Hobe Sound in the vicinity of Jensen, and north of Cocoa, the high dunelike sand ridges extend to the water's edge and stand out prominently as bluffs.

The shore of the mainland is variable, but for the most part rises abruptly from the water's edge 3 to 10 feet and thence gradually, usually into a high sand ridge which parallels the coast, and stands from 30 to 40 feet above sea level, with occasionally higher points. Usually this is a single-crested ridge, but in places the crest has some undulations or is of dunelike character. On the west it generally slopes abruptly to sloughs or shallow ponds and lakes and thence passes inland into the level flatwoods. The flatwoods, with its shallow depressions, usually lies from three-fourths to 1 mile from the shore. It is marked by occasional low ridges or undulations, the remnants of old coastal beaches.

In places the forelands along the mainland shore are swampy or consist of low, wet hammock and occasionally typical pine flatwoods, but these are always flanked by higher lying land.

The barrier or cordon of coastal islands lies off the mainland at varying distances, being separated from it by sounds and lagoons, the water in which is kept salty through tidal action, a number of inlets connecting the sounds with the ocean. These lagoons and sounds have been separated in part by swampy land, but they are now continuous or connected by canals constructed as parts of an inland waterways system. The different bodies of water have local names. The lagoon in the extreme southern part of the area is known as Lake Worth. It varies in width from one-half mile at West Palm Beach to about 1½ miles at the inlet 6 miles north. It has been connected with the south Jupiter Narrows by dredging a canal between them through the large saw-grass pond.

North of Jupiter to the St. Lucie River the sounds are narrow, being encroached upon throughout most of the length by mangrove swamps. From St. Lucie Inlet the sound, or, as it is here called, Indian River, broadens, having a breadth in most places of 1 to 2½ miles. Opposite Eau Gallie the river divides to flow around Merritts Island and becomes somewhat narrower, with rocky shores and deep water, broadening again above Cocoa, until at Titusville the distance is 5 miles to Merritts Island. The east arm becomes a broad lagoon 3 or 4 miles wide known as the Banana River. At the north it connects with Indian River opposite Titusville by Banana Creek, a shallow stream flowing through salt marshes.

These inland waters have been made navigable to small craft, where necessary, by dredging and by marking out the natural deeper channels.

While the strip of mainland surveyed constitutes a ridge throughout most of its extent, it is broken by a number of fresh-water streams rising in the flatwoods of the interior and emptying into the lagoons or sounds. These streams remove the water of the flatwoods included in the strip surveyed, but they do not effect thorough drainage. Levels run by the county engineers show these flatwoods areas to be several feet above tide level and capable of drainage by cutting a sufficient number of outlets through the coastal ridges. The lower forelands, however, lie but little above sea level. They are drained to some extent at seasons of the year when water in the lagoons is at a low level. The higher lying lands consist of loose sand and are for the most part excessively drained, the water percolating rapidly and seeping into the low levels on either side.

The early settlers within this area came from the older settled sections in the northern part of the State and from near-by Southern States, particularly Georgia and North and South Carolina. Settlement had hardly begun before 1850 and progressed very slowly. Some settlers have come from the Northern States, particularly since 1870. Immigration, though slow, has been gradually increasing, and there are now representatives of all the States, as well as many foreign countries. Besides the permanent residents, there is a large transient population during the winter season, there being a number of popular resorts within the area. Settlement has been almost entirely confined to the shore of the mainland and the islands along the coast.

The largest towns of the area are the county seats of the three counties, all of which are rapidly gaining in population. West Palm Beach, the county seat of Palm Beach County, a newly formed county, is widely known as a winter resort. The other towns of this county included in the survey are Jupiter, Hobe Sound, and Stuart. Fort Pierce, the county seat of St. Lucie County, had a population according to the 1910 census of 1,333 and is an important business place, being division headquarters of a railroad and having an important fishing industry. Other towns in the county are Jensen, Wabasso, Sebastian, and a number of smaller ones, all more or less important shipping points for pineapples. The county seat of Brevard County is Titusville, with a population of 868. This is the oldest town in the area and has an important fishing industry. Cocoa has a population of 613 and is an important shipping point for citrus fruits, handling not only those grown in the immediate section on the mainland but also the large production from Merritts Island. Rock Ledge, adjoining Cocoa, is a popular winter resort. Other important towns of the county south of Titusville and included in the survey are

Melbourne, Eau Gallie, and Malabar. There are a number of smaller towns that are developing. In the counties surveyed all the large and small towns are growing and new towns are being laid out. These towns include the homes of winter residents and of those who take up for cultivation lands near by in the interior. The rural population in most parts of the area is sparse.

The area surveyed is traversed throughout its length by the Florida East Coast Railway, which extends throughout the length of Florida south to Key West at the tip of the Florida Keys, connecting there with steamship lines to Cuba and Central and South American ports. It affords good passenger service and is the rail outlet for the transportation of the products of the east coast to northern markets. Water transportation is also afforded by the sounds and connecting canals along the coast.

A wagon road follows the railroad more or less closely throughout the area, being a part of the main highway along the coast and of the system of highways of the State. For the most part this road has a hard surface of either limestone, shell, or marl, and work is being pushed on the few short intervals that have not been surfaced. A number of roads, some of which are surfaced, have been built from the main highway into the back country and others have been projected.

There is a good demand for vegetables and fruits in the local towns and resorts. Where grown in sufficient quantities to justify it, however, these products are sent by express or in car lots to northern markets. Citrus fruits are the most important products shipped out of the area. Practically the entire pineapple industry of the State has been developed in this area and the product reaches all parts of the country. Snap beans are the most important trucking crop shipped to northern markets. Tomatoes are shipped to a smaller extent.

CLIMATE.

The climatological data for the area are compiled from the observations taken at the Jupiter and Merritts Island stations of the Weather Bureau. The former is in Palm Beach County and the latter on Merritts Island opposite Cocoa, Brevard County. Both these stations are on islands, the one at Jupiter being located at the lighthouse. The periods of uninterrupted observations are 21 years at Jupiter and 17 years at Merritts Island, the latter coming up to 1908 only. The data collected at these stations are shown in the accompanying tables, which give the normal monthly, seasonal, and annual temperature and precipitation and the actual and average dates of killing frosts:

Normal monthly, seasonal, and annual temperature and precipitation, at Jupiter, Fla.

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.
	°F.	°F.	°F.	Inches.	Inches.	Inches.
December	66.3	86	24	2.83	2.56	1.96
January	64.3	83	24	3.50	0.36	5.20
February	66.3	87	27	2.79	0.95	5.14
Winter	65.6			9.12	3.87	12.30
March	69.4	89	33	3.01	3.26	3.65
April	72.2	90	39	2.40	1.90	8.47
May	76.4	93	53	4.86	1.15	10.73
Spring	72.7			10.27	6.31	22.85
June	79.6	95	64	6.90	0.12	4.67
July	81.0	96	68	5.29	6.80	5.89
August	81.5	95	68	5.69	6.62	6.85
Summer	80.7			17.88	13.54	17.41
September	80.6	93	61	9.36	3.38	18.09
October	76.8	94	48	10.00	10.89	9.93
November	71.6	87	42	3.19	1.11	6.49
Fall	76.3			22.55	15.38	34.51
Year	73.8	96	24	59.82	39.10	87.07

Average date of first killing frost in winter, Dec. 29; of last in spring, Feb. 14. Earliest actual date of killing frost, Nov. 18; of latest in spring, Apr. 7.

Normal monthly, seasonal, and annual temperature and precipitation, at Merritts Island, Florida.

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute Minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.
	°F.	°F.	°F.	Inches.	Inches.	Inches.
December	63.2	85	22	2.52	3.46	1.38
January	62.0	82	24	3.05	0.30	10.45
February	64.1	86	22	2.70	1.22	4.37
Winter	63.1			8.27	4.98	16.20
March	67.6	88	37	2.52	0.68	7.92
April	71.7	90	40	2.87	0.51	9.74
May	76.5	96	55	3.76	0.73	1.47
Spring	71.9			9.15	1.92	19.13

Normal monthly, seasonal, and annual temperature and precipitation, at Merritts Island, Florida—Continued.

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.
	°F.	°F.	°F.	*Inches.*	*Inches.*	*Inches.*
June	79.6	94	66	6.92	0.64	3.32
July	81.4	95	68	5.50	6.12	5.04
August	81.6	97	64	5.42	8.69	5.70
Summer	80.9	.....	.....	17.84	15.45	14.06
September	80.3	92	56	7.94	3.97	23.78
October	75.6	93	50	5.72	5.69	6.41
November	68.5	89	34	2.30	1.43	1.02
Fall	74.8	.....	.....	15.96	11.09	31.21
Annual	72.7	97	22	51.22	33.44	80.60

Average date of first killing frost in winter, Jan. 8; actual earliest date of killing frost recorded, Dec. 21; actual latest in spring, Feb. 19.

Since the area lies along the Atlantic Ocean, the climate is equable and, as a rule, not subject to the abrupt changes that may occur inland. By referring to the table it will be seen that the mean annual temperature at Jupiter is 73.8° F. and at Merritts Island 72.7° F., a difference of 1.1° over a distance of about a degree and a half, Merritts Island being approximately that distance north of Jupiter. The highest recorded temperature for the area is 97° F., at Merritts Island in August, but on the mainland at stations on the shore the maximum is higher, a temperature of 100° F. having been recorded at Malabar, in the southern part of Brevard County, and 98° F. at Fort Pierce, in St. Lucie County. As shown by the tables, there is very little difference in the monthly and seasonal maximum temperatures throughout the length of the area, and, as in the case of the Florida Peninsula as a whole, whatever discomfort there may be is due to the monotony of long-continued periods of uniform heat. This condition, however, is here ameliorated by the ocean breezes. In the summer season the early morning period from sunrise to about 9 o'clock, owing to the high humidity and lack of wind, may be warm and uncomfortable, but as soon as the ocean breeze springs up the atmosphere becomes pleasant and even invigorating, although the sun is brighter and the temperature higher. There is also a period at sunset and during the early evening when the wind dies down and the conditions of early morning are repeated.

The winters are mild and pleasant. The mean temperature for the winter months is 63.1° F. at Merritts Island and 65.6° F. at

Jupiter. There occur cool spells, generally accompanied by rain, known as "northers," when there is a considerable fall in temperature, but these usually do not last more than two or three days. The absolute minimum temperature recorded at Merritts Island is 22° F. and at Jupiter 24° F., but such low temperatures are of rare occurrence, and there may be a succession of years when the temperature will not touch the freezing point. Frosts, generally light, may be expected from the latter part of November to April 1, but they usually occur only in January and February. When killing frosts occur they do much damage. Those of 1894–95 reached into this section, destroying most of the orange trees and doing great damage to the pineapple industry, which had been widely developed. The influence of elevation and consequent air drainage is strikingly illustrated in this area, as trees and plants growing on the rolling sand ridges are much less likely to be injured during freezes than on the flat lands farther south.

The mean annual precipitation at Jupiter is 59.82 inches and at Merritts Island 51.22 inches. At Fort Pierce, on the mainland, it is 55.31 inches and at Malabar 48.89 inches. The year comprises a wet and a dry season. The dry season begins about November and lasts until April or May, the winter and spring seasonal means being approximately about 10 inches each. In May or June the rainfall increases, being heaviest in September and October. The record shows that at Merritts Island there is an average of 92 days a year with 0.01 inch of precipitation, at Jupiter 136 days, and at Malabar and Fort Pierce 89 and 91 days, respectively. At Jupiter during every month, except February, March, and April, there are from 10 to 18 rainy days, the largest number occurring in September, while at Merritts Island the months during which there are 10 or more rainy days are June, July, August, September, and October. The rains are frequently torrential and several inches may fall in a few hours. Even during the so-called dry season heavy rains occur. In the summer time, especially in the southern part of the area, the rains are of a tropical character, occurring as showers in the afternoon.

AGRICULTURE.

The early settlers in this region located on favorable sites along the shores. They grew a few vegetables and staples for their own use, but subsisted mainly by fishing and hunting. There was no market for agricultural products. For a number of years the only means of communication with older settlements north was a wagon trail which extended from Jacksonville to the forts at Miami, the sounds and lagoons along the coast not being connected for passage by boats. In 1881 communication by steamboat was opened on the St. Johns River from Sanford to Lake Poinsette, the latter being a

few miles back of Cocoa. This route was used until in the nineties, and meanwhile, about 1890, a canal was dug between the Indian River and Mosquito Lagoon, so that boats of light draft could pass on north. In 1886 a branch railroad was completed from Enterprise, an inland railroad point, to Titusville. This railroad became the outlet for products grown as far south as Jupiter. A narrow-gauge railroad was built which connected Jupiter with Juno, on Lake Worth, giving that section an outlet for its products.

However, the greatest factor in opening up this section was the building of a railroad down the coast. In 1891 what is now the Florida East Coast Railway was completed to Titusville and a few years later extended down the coast to Miami, and within the last two years it has been built to Key West. This railroad furnished a more rapid means of transportation, so that the more perishable vegetables could be shipped to northern markets during the winter months. It entirely displaced the boat lines, and only recently has water transportation been resumed to any extent.

While numbers of settlers came in after 1870, they were scattered along the coast, and it was not until the eighties that special crops were grown for market. The growing of vegetables in the winter for the northern markets offered good inducements. Trucking was started at a number of places. At Juno, on Lake Worth, the production of snap beans proved to be very profitable, and a number of other bean-growing sections were developed at this time or a little later, including the islands opposite Quay and those opposite Jensen. These two places are now the most important centers for the production of snap beans, the crop having been abandoned some years ago in the Lake Worth region. With the extension of the railroad down the coast tomato growing was taken up to some extent, especially in the vicinity of Quay.

Citrus-fruit growing is the most important industry in the area surveyed. Oranges and other citrus fruits were cultivated during the early settlement of this section of the State. As early as 1852 an orange grove was started a few miles north of Titusville, outside of this survey, by budding the sweet orange on the sour-orange stock. There was also a grove in the vicinity of Ankona, in the present St. Lucie County, that was budded about this time with the sweet orange. With the development of transportation facilities the production of oranges became a very important industry. The groves were damaged by the freezes of 1876 and 1886, especially the latter, but these checks were only temporary, and the planting increased until by the time of the freeze of 1894–95 there is said to have been in the northern part of the area, where the industry was developed, more orange trees in bearing than at the present time. The largest

bearing groves are in Brevard County, in the vicinities of Rock Ledge and Cocoa and on Merritts Island. Cocoa is the shipping point for this section. The crop is confined mainly to the hammock lands, which are best adapted to it in both high and low situations, although there are trees on all the soil types of the area. The area of low hammock land devoted to fruit is small,the larger acreage being grown on the yellow subsoil phase of the St. Lucie sand and on the Norfolk fine sand.

All the soils, wherever situated, have been found to require fertilizers for best results, especially as regards yield. Although on the low hammocks, especially where underlain by marl, there is not considered to be so much need for fertilizers, the better growers use large quantities on all the soils, as fertilized groves give fruit of better size and quality. Various mixtures are used.

The varieties of oranges grown are the Indian River, Pineapple, and Valencia, or Harts Late. Until recently the Indian River, which is a variety of local origin, was largely grown to the exclusion of other varieties, but now it is being superseded to a considerable extent in present plantings by the Pineapple orange and the late varieties, Valencia, or Harts Late.

Grapefruit plantings are being extended probably even more than those of the orange. The fruit is of excellent quality and is grown on the same soils as the orange. The Duncan and Excelsior are the principal varieties. There is a considerable production of tangerines and some King oranges are produced. Limes and lemons are grown, but not in sufficient quantities to ship.

The growing of pineapples, which was also begun in the eighties, became as important an industry as the growing of oranges. As late as 1894–95 the industry was developed beyond the northern limits of this survey. There was a considerable acreage devoted to this crop on Merritts Island and on the peninsula or island opposite Melbourne. During the freeze of 1894–95 the crop was completely destroyed; since that time the pineapple acreage has been greatly restricted. The fields in this crop are now confined to what is known as Pineapple Ridge, extending from a point a few miles north of Fort Pierce south to the St. Lucie River, a distance of about 25 miles, and thence along the St. Lucie River to the vicinity of Stuart in Palm Beach County. Farther south, at Gomez Station, in Palm Beach County, is another section, but the growers here are abandoning their fields, stating that there is no profit in the crop. At West Palm Beach the pineapple fields are being divided into residence lots and the fields are being abandoned. In St. Lucie County along the sand ridge there is an almost unbroken succession of fields. The belt is narrow, averaging about one-fourth mile wide, but in places reaching one-half mile.

While fancy varieties were formerly grown quite commonly, practically only one variety is grown at present. This is the Red Spanish, a Cuban variety, which seems best adapted to the soil and climate. The crop is given liberal applications of fertilizers, generally in two applications, amounting to a ton or more an acre. The first application is made in October to develop the main crop that is harvested in May and June and the other in June at the close of harvesting to produce plant growth. While the main crop is harvested in June, the fruit is gathered throughout the year. About 150 crates per acre is the ordinary yield, but much larger yields are sometimes obtained.

New fields are started by planting slips in July and August in rows or checks about 20 by 20 inches. These are at first cultivated and fertilizers high in nitrogen employed, and as the plants near bearing time more phosphorus and potash are applied. The second June, or 22 months after planting, the first picking is taken. The fields are in their prime at 5 or 6 years. The plants soon cover the ground and as weeds do not grow well on these soils they are not troublesome. No work is done beyond broadcasting the fertilizer by hand, the rains washing this down into the soil. The plants are left 10 or 12 years and sometimes longer, but usually it is best to replant.

Pineapple growing has been very profitable the last few seasons, but there were a few years during which very little, if any, profit was derived from it. The only competition to be met by growers of the Florida pineapples is from producers in Cuba and Jamaica.

The white siliceous sands, or St. Lucie soils, are adapted to this crop, and the ridges are better than the flat lands. It does not succeed on hammock lands. The bearing pineries range in value from $500 to $2,500 or more an acre, according to the condition of the crops. The raw uncleared land brings from $75 to $150 an acre.

Besides the citrus fruits and pineapples the guava is grown throughout the area, and jelly is extensively manufactured from it. This fruit succeeds well on all the well-drained soils. Bananas are grown quite generally, but not in a commercial way to any considerable extent. Moist places along draws with mucky soils are best suited for growing bananas. While the banana does not reach the size of the imported fruit, it is of good quality and is in demand on the local markets. Both the sweet and "horse" banana are grown, the latter requiring cooking to be edible. The papaw and the mango are found throughout the area. There are many other fruits of less common occurrence. In the southern part of the area, especially along Lake Worth, the coconut, which grows in abundance, is a source of considerable revenue. Another wild fruit of some commercial impor-

[1] Bulletin 13, U. S. Dept. of Agr., The Soils of Florida, p. 17.

tance, mainly in the region around Cape Canaveral, is the saw palmetto berry, which is gathered and shipped for the preparation of medicinal products. The berries are sun dried and bring from 4 or 5 to 25 cents a pound. A good many tons of this berry are gathered annually. Sweet potatoes do well. Watermelons and cantaloupes succeed on nearly all but the low hammock soils, and the growing of both of these crops could probably be increased profitably.

There is little general agriculture in this section of the State. All farmers grow garden vegetables, sweet potatoes, and fruits for home consumption, but the production even of these necessities is small. Besides the special fruit crops—pineapples and citrus fruits—trucking is specialized in certain parts of the area. String beans are an important crop in the Quay section, on the islands, and opposite Jensen. The product is of good quality and is harvested at a time to bring the highest prices in the northern markets. New York City gets the better grade. The green varieties are grown principally, the most common being "Refugee" or "Thousand to One." Some yellow wax beans are grown, mainly the Wardwell, Davis, and Hudson's Wax.

The planting of beans is begun about October 1 and is continued into January. The pickings begin in 60 days, and the last beans are picked in April. As a rule only one crop of beans is taken from the land the same season and no other crop follows. About 150 crates or hampers, averaging 30 pounds each, is considered a fair acreage yield. Fertilizers are applied in varying quantities, but the more successful growers use 1,000 to 1,200 pounds of a 6–5–8 formula to the acre.[1] The growing of the beans is expensive, as the cultivation is all done by hand. After the crop is harvested the weeds are allowed to take possession of the fields, being cut down and burned when dry. Most of the weeds have been introduced into the area, the ragweed being most abundant. A nightshade, locally known as "shoestring," from its long, slender roots, is most troublesome.

A pest in the bean fields at times is the green fly. In places the damage has been so great that the growing of beans has had to be discontinued. No way has been found to successfully combat this insect. The growing of beans is confined to the Palm Beach and Gainesville soils, all of which are hammock lands.

The farms and land holdings are usually small, farms having been subdivided in the last few years. Most properties in the area surveyed are narrow and confined to the coast, having a small frontage on the water and extending back from one-fourth to one-half mile or more. The water frontages, especially near towns and those suitable for building sites, are held at high prices. The values vary greatly, depending upon the buildings and the number and bearing stage of

[1] Fertilizer formulas are stated in the order, phosphoric acid, nitrogen, and potash.

the fruit trees planted. Desirable hammock lands rarely sell below $100 an acre, while the loose sands, outside of the pineapple district, are considered practically worthless.

Labor is scarce and commands high wages. The negro population, though not large, is the main source of labor. In the picking and packing of fruit, however, considerable numbers of whites are employed. Many of the latter are from the Northern States.

SOILS.

In point of origin of material the soils of the Indian River area belong in three principal groups, as follows: (1) Cumulose soils, or those composed chiefly of decaying vegetal remains which have accumulated in water or very wet places from the plants growing therein, such as Muck (the latter including patchy occurrences of Peat); (2) unconsolidated marine material, composed chiefly of quartz sand or quartz sand and fragments of sea shells, and locally influenced by vegetable matter from growing plants, such as the Palm Beach, St. Lucie, Norfolk, Portsmouth, and Plummer soils; and (3) residual or partly residual soils, containing material derived from the underlying rock through processes of weathering, such as the Gainesville and Parkwood soils.

Topography and position, as affecting drainage and completeness of weathering, have been the chief factors in producing the important differences in the soils derived from unconsolidated marine sediments, which differences have been recognized in the classification of the soils by grouping them in series.

The classifications Coastal beach, Swamp, Tidal marsh, Shell mounds, and Madeland are not considered true soils, for the reason that they have not become sufficiently weathered or do not represent sufficiently definite material to be classified as such. The material of the Coastal beach, Swamp, and Tidal marsh classifications represents the most recently formed land areas of natural origin.

The Palm Beach soils are the brownish soils lying just behind Coastal beach. The soils represent Coastal beach material which has been weathered and changed in color by the accumulation of vegetable matter from the luxuriant growth of plants that has established itself upon this material.

When through long-continued processes of weathering the Palm Beach material has been freed of the fragments of sea shells, leaving a residue mainly of quartz sand, the material has given rise to several different groups of soils, depending on the processes of later weathering, but chiefly upon drainage conditions, as determined by topography.

The best drained soils back from the Palm Beach lands are the St. Lucie and Norfolk. Both of these series comprised well-drained

soils derived from unconsolidated marine deposits. In this area each series is represented by two types, the sand and the fine sand.

In the poorly drained flatwoods and depressions two series of soils have been derived from unconsolidated marine material, the Portsmouth and the Plummer. The former comprises the greater proportion of the flatwoods, the latter occurring in shallow depressions which are intermittently covered with water and dry at the surface.

The soils formed through the decay of underlying rocks are represented by the Gainesville and Parkwood series. The former are underlain by limestone, mostly coquina, usually within the 3-foot section, and the material or much of it appears to be derived from this underlying stratum. The Parkwood soils occur in low, poorly drained situations. The typical residual material consists chiefly of clay or clayey marl, while the surface sandy material of the sandy members of the series apparently represents originally unconsolidated material blown over the residual products.

In the following chapters the various soils and land classifications are described in detail, and their agricultural value brought out in so far as this point could be determined through the crops grown and the relation of the soils to the same or similar lands utilized in other areas for agricultural purposes.

The table below gives the names and the actual and relative extent of the various types mapped in the area:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
St. Lucie sand	13,312	30.9	Norfolk fine sand	4,800	2.2
Flat phase	36,224		Palm Beach fine sand	4,288	2.0
Yellow subsoil phase	16,704		Plummer sand	3,264	1.5
Hammock phase	1,024		Parkwood fine sand	2,944	1.3
Portsmouth sand	30,592	14.4	Gainesville sand	2,304	1.1
Hammock phase	896		Parkwood sand	2,240	1.0
Tidal marsh	21,888	10.0	Parkwood clay loam	256	.9
Portsmouth fine sand	18,688	8.7	Prairie phase	1,664	
Hammock phase	192		Parkwood sandy loam	1,792	.8
Muck	5,120	7.9	Swamp	1,088	.5
Hammock phase	3,648		Madeland	1,088	.5
Mangrove swamp phase	8,576		Norfolk sand	832	.4
Palm Beach sand	14,272	6.5	Gainesville loamy fine sand	512	.2
Coastal beach	7,744	3.6	Shell mounds	192	.1
St. Lucie fine sand	6,528	3.2			
Yellow subsoil phase	448		Total	218,240	
Parkwood fine sandy loam	5,120	2.3			

ST. LUCIE SERIES.

The St. Lucie soils are characterized by their white color, loose structure, and extremely droughty nature. The soil material consists of almost pure quartz sand, free from vegetable matter. The

hardpan layer found in the associated Leon series does not occur in the St. Lucie within the 3-foot profile, but may be found in the deep substratum. These soils support a desert type of vegetation, such as oak scrub with thick, leathery leaves, prickly pear, etc. Spruce pine and saw palmetto are common. The surface is flat to hummocky and ridgy. It is always noticeably elevated above the associated flatwoods soils. The most extensive areas mapped are those along the east coast of Florida.

ST. LUCIE SAND.

The St. Lucie sand consists of a clean white sand of medium texture having a depth of over 3 feet. The material apparently consists wholly of siliceous particles, no other minerals being discernible. The immediate surface of uncleared areas usually carries a little organic matter, but not more than enough to impart a light shade of gray. Its surface configuration is characteristically hummocky, hillocky, or ridgy. This soil represents high beach land or dune-sand which has become fixed or quiescent through the establishment of vegetation, although some of it, especially near Hobe Sound, is still drifting slightly. It occurs throughout the area as a well-defined hillocky ridge, with some smoother undulating areas. It reaches the highest elevation attained in the area at Hobe Sound, 63 feet above sea level.[1] In St. Lucie County the ridge is very pronounced. It is here known as "Pineapple Ridge," owing to the fact that it is or was devoted entirely to pineapples. It also extends through Brevard County, with some interruptions.

Aside from its value for pineapples, the land is considered worthless. The pineapple succeeds better on these ridges than on the flat areas, probably because of the better air drainage on the elevations, less damage being caused by frost. The higher land is excessively drained, but supports the same growth as the flat areas—spruce pine, scrub evergreen oak, and saw palmetto.

The pineapples receive heavy applications of fertilizers a number of times a year and good yields are obtained. Because of its adaptability to pineapples this land has a high value, particularly in St. Lucie and northern Palm Beach Counties, where the pineapple industry is chiefly developed (see Pl. IV, fig. 1). Here from $75 to $150 an acre is paid for the uncleared land. After it is cleared and set to pineapples the value is, of course, much higher—several hundred dollars an acre. Outside the pineapple district the land is considered practically worthless.

Some oranges, grapefruit, flowering plants, and ornamentals are grown under exceptionally good care.

[1] According to records of the county surveyor.

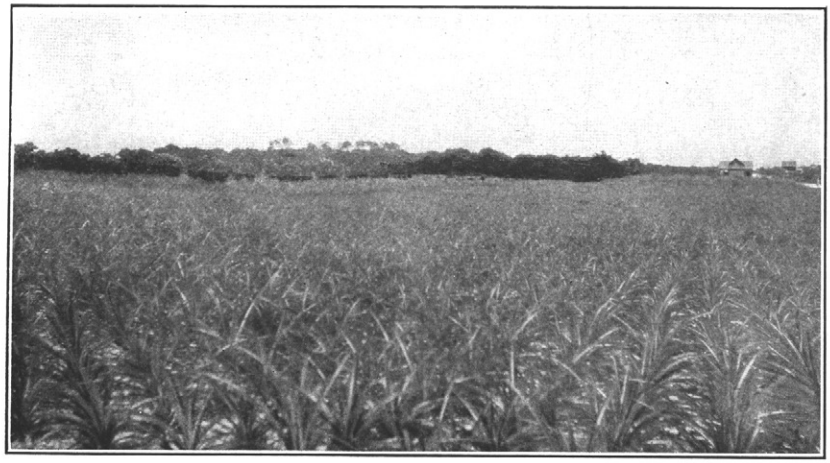

FIG. 1.—PINEAPPLES ON ST. LUCIE SAND NEAR FORT PIERCE.

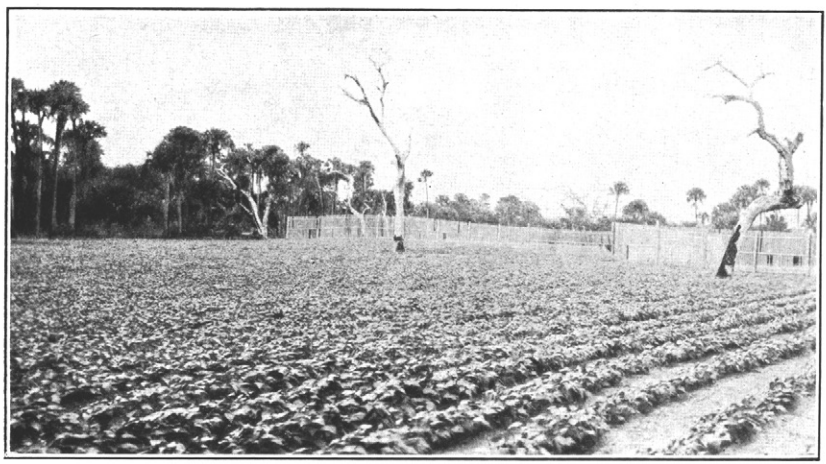

FIG. 2.—STRING BEANS ON PALM BEACH SAND ON ISLAND OPPOSITE JENSEN.

Windbreaks in background made of slats.

In this area the St. Lucie sand as described is locally known as "white sand" or "spruce pine and evergreen oak scrub land."

The St. Lucie sand is the most extensive type mapped, covering 30.9 per cent of the area.

Variations are found in topography, vegetation, and subsoil, and these have been separated as phases of the type.

St. Lucie sand, flat phase.—The St. Lucie sand, flat phase, consists of the same white siliceous sand as the main type. Its distinguishing difference is one of topography, the surface being characteristically flat, with only occasional slight hummocks and depressions. This phase supports a scattered growth of spruce pine, longleaf pine (*Pinus caribbea*) of short, gnarly or twisted growth, and an undergrowth consisting principally of low evergreen scrub oak, or saw palmetto, or a mixture of these. North of Eau Gallie, however, the longleaf pine changes to another species, the longleaf yellow pine (*Pinus palustris*), with only a scattering of the spruce pine. Wire grass is found to some extent on this phase, while in some of the lower poorly drained situations the gallberry is abundant.

This soil is very irretentive of moisture. Even after considerable rain the surface soon dries. The soil is very droughty. Even in low spots where it becomes saturated occasionally, it remains so for only a short time. Naturally this soil is of low productiveness. With heavy applications of fertilizer vegetables can be grown successfully in seasons of favorable rainfall. To insure success through dry spells surface irrigation or sprinkling is necessary. Pineapples are the only crop of importance that has been found to grow successfully on this soil under the existing conditions of moisture, and this crop must be heavily fertilized. At West Palm Beach there are some small citrus groves on this phase, but they are irrigated and the trees are kept constantly mulched. The fruit is of good quality, but "russets" badly.

St. Lucie sand, hammock phase.—The surface soil of the St. Lucie sand, hammock phase, is a medium sand of dark-gray to brownish color, which at about 8 to 12 inches changes into the white sand that characterizes the other St. Lucie soils. The dark surface color is imparted by an accumulation of vegetable mold.

Narrow strips of this phase are found along the shores and as high forelands, especially below Fort Pierce, in St. Lucie County. The total extent is small.

This phase, as indicated by its name, supports a heavy hammock growth, consisting chiefly of cabbage palmetto, live oak, magnolia, hickory, and a dense undergrowth of shrubs. The hammock growth is no doubt brought about by better conditions of moisture.

St. Lucie sand, yellow subsoil phase.—The yellow subsoil phase of the St. Lucie sand consists of the characteristic St. Lucie white sand,

frequently grayish in the immediate surface owing to vegetable matter, underlain at any point within the 3-foot section by orange-yellow sand extending to over 3 feet. While as a rule the line of demarcation between soil and subsoil, as seen in cuts, is sharp, yet, especially where the soil is shallow, there is a gradational layer of amber-yellow sand which passes gradually into the deeper yellow sand. In places the lower subsoil becomes somewhat reddish. The yellow sand possesses a slight coherency or loaminess.

The depth of the gray soil varies greatly, ranging from a thin veneer of an inch or two to nearly 36 inches. The yellow subsoil, however, is encountered usually from 6 to 20 inches beneath the surface. Where the gray soil is as deep as 36 inches it has been included with the typical soil, even though a yellow soil is found in the substratum.

This phase is found throughout the area associated with the main type. Most of it occurs on the east slopes of the ridges of the St. Lucie sand. In some places it also occupies the west slopes and crests of ridges. On the barrier island, from the vicinity of Cape Malabar northward to near Sprig Point, and again west of Cape Canaveral, it forms the succession of ridges between the Tidal marsh and the Coastal beach along the ocean. These are the largest areas encountered, and are covered with saw palmetto and some evergreen scrub oak. In Palm Beach County the natural growth is identical with that found on the main type and the flat phase, except that the trees may be a little larger and the woods more open, but in St. Lucie and Brevard Counties it is in contrast with the surrounding vegetation of the main type, consisting more of hammock growth, hickory being particularly noticeable, and the land is locally known as "hickory hammock." There is on the mainland areas a dense growth of evergreen scrub oak, the trees being of larger size than usual, with other bushy growths and pines.

This yellow subsoil phase is considered much more productive than the typical St. Lucie sand. In the pineapple district the strips with yellow subsoil are devoted largely to citrus fruits. The trees make a thrifty growth and bear well, producing fruit of excellent quality. They are heavily fertilized, however, as on other soils. Pineapples are also grown with good results, although they are inclined to make "spiky" or elongated fruit with little good flesh.

ST. LUCIE FINE SAND.

The St. Lucie fine sand typically consists of light-gray to white loose fine sand, 3 feet or more deep, the immediate surface being slightly grayish, owing to the presence of a small amount of organic matter. It occupies flat to low ridgy areas on the mainland strip in Brevard County and on Merritts Island. These areas support a growth identical with that of the St. Lucie sand of this section of

the area, that is, longleaf yellow pine, with some spruce pine and an undergrowth of evergreen scrub oak and saw palmetto.

The type is not under cultivation except where it comes in contact with areas of other soils. Its finer texture makes it a somewhat better soil than the St. Lucie sand, it being a little more retentive of moisture. With surface irrigation (by the sprinkling process) and the incorporation of organic matter the soil could be successfully used for some vegetables. It would probably be very well suited to the growing of watermelons. While the pineapple industry was abandoned in Brevard County after the freezes of 1894–95, prior to which some pineapples were grown on this soil, there is now a small patch or two on Merritts Island on which pineapples are successfully grown. Some citrus fruits—oranges and grapefruits—are grown on this type on Merritts Island, but it is not so highly esteemed for this purpose as the Norfolk fine sand, with which it is associated. The trees require fertilization for good growth and mulching to conserve the soil moisture.

St. Lucie fine sand, yellow subsoil phase.—The yellow subsoil phase consists of a light-gray to white siliceous fine sand underlain by orange-yellow fine sand. The soil is loose, while the subsoil has a slight coherence. The depth of the white-sand mantle varies from about 4 to 30 inches, the yellow sand usually being encountered at 6 to 15 inches. It is found in a few small areas in Brevard County on the mainland and on the peninsula in the vicinity of Oceanus.

The areas of this phase lie well for cultivation and drainage. The soil has good to rather excessive drainage. On the mainland there is present the same vegetation as on the other sandy soils, along with some hickory. On the peninsula saw palmetto is the predominant growth, with some evergreen scrub oaks. The extent of this soil is so small as to make it relatively unimportant. The areas on the peninsula are too near the ocean to be of much value agriculturally, but those areas on the mainland have some value, as citrus fruits can be grown on them.

Norfolk Series.

The Norfolk soils are characterized by the light-gray to grayish-yellow color of the surface soils, and by the yellow color and friable structure of the subsoils. They occupy nearly level to rolling uplands throughout the Atlantic and Gulf Coastal Plain. The sandy members predominate. Two members of the series, the sand and fine sand, occur in the present area.

NORFOLK SAND.

The surface soil of the Norfolk sand to a depth of about 5 to 10 inches consists of a grayish medium sand. This is underlain by pale-yellow to yellow medium sand to depths exceeding 36 inches. The

upper portion of the subsoil often has a gradational layer of yellowish gray sand before the more decidedly yellow material is encountered. In some parts of the areas north of Eau Gallie the upper subsoil is stained brownish yellow or very pale amber. The surface soil gets its grayish color from the small quantity of organic matter incorporated.

The type occurs only in Brevard County, where it lies in narrow strips following crests of low ridges. It supports a growth of long-leaf pine, which attains a good size, some oak scrub, and a good sod of wire grass. Saw palmetto is scattered. The most characteristic growth consists of forked-leaf blackjack oak. There is also some hickory.

Only a small total area of this soil occurs and thus far it has not been put under cultivation. It is a better soil than the St. Lucie sand, and beyond the northern limits of the survey some citrus fruit is produced on the type.

NORFOLK FINE SAND.

The surface soil of the Norfolk fine sand consists of a light-gray fine sand, while the subsoil is a yellow fine sand to a depth of several feet. The depth of the surface soil is usually from 6 to 10 inches, but there is considerable range, the yellow subsoil in places lying as deep as 15 to 24 inches and occasionally 30 inches. Where so deep the sand becomes white immediately beneath the surface and is very similar to the St. Lucie fine sand, not being distinguishable until the characteristic yellow subsoil is reached. The yellow of the subsoil is not the orange yellow of the yellow subsoil phase of the St. Lucie. In the locality from Eau Gallie southward to Turkey Creek occurs the phase having the greatest depths of surface soil. Northward the soil becomes more typical, especially on Merritts Island, where the shallowest surface soil is found.

The surface soil is darkened by leaf mold and partly decomposed organic matter. It is rather loose and incoherent, and the traveled roads through it become deep with sand. The subsoil is fairly compact and possesses a slight degree of loaminess or coherence.

The Norfolk find sand is found only in Brevard County northward from Turkey Creek. It occurs in a number of areas, being interrupted by areas of St. Lucie fine sand and sand. The areas occur in strips following ridges and as rounded knolls. The surface is flat to gently rolling. It also occupies hummocky areas in the flatwoods on both the mainland and Merritts Island. It forms the soil on the elevated land, or ridge, on the west side of Merritts Island from Lake Wittfeld north to Courtenay, with some interruptions by other types. It lies well above the water level of Indian River, about 8 to 15 feet on the average, with some points probably 30 to 40 feet. This position makes it thoroughly drained, yet owing to its fine texture it

conserves considerable moisture, especially where the surface is mulched by cultivation.

The forest covering on the typical areas of the Norfolk fine sand differs somewhat from the associated well-drained St. Lucie soils and the black soils of the flatwoods. The saw palmetto is scattering or entirely absent and forked-leaf blackjack oak, water oak, and turkey oak are present. The evergreen oak scrub is found upon it, especially on Merritts Island. Longleaf yellow pine is always present. Some areas of the type where water oak and turkey oak abound constitute "open pine woods" having a good cover of wire grass. Wire grass thrives on this type wherever the tree and scrub growth is not too thick.

Much of the Norfolk fine sand occurs near or along the shore of the mainland and on Merritts Island in particular, and is desirable for building sites. Its position near the water, where temperatures are moderated, also makes it desirable for citrus fruits. The most extensive groves in the area are located on this soil, and where cultivated it is used for little else.

For trucking it would require irrigation, as these crops are grown during the dry season or season of moderate rainfall, that is, during the winter and spring months. With good management this soil could be made to produce a number of crops, such as vegetables, melons, cantaloupes, velvet beans, cowpeas, and peanuts. On Merritts Island the type has been devoted to citrus fruits for a long time and there are some trees in the groves over 40 years old. Most of the trees, however, were killed or damaged by the freeze of 1894–95. These have been replaced to a considerable extent since that time, though it is said the area in groves is not as large as before the freeze. The plantings are being extended each year. Oranges, grapefruit and tangerines are grown. The fruit is of superior quality and the section has long been known as the principal center of the Indian River orange section. An orange known as the "Indian River" has until recently been the principal variety. It is of excellent quality, but such varieties as the Pineapple and Valencia are superseding it.

Grapefruit or pomelo groves are now coming into full bearing, representing a comparatively recent addition to the citrus-fruit industry. Both the orange and grapefruit are sweeter than those grown on lowlands, but the fruit "russets" considerably, the proportion of "brights" being less. Russeting does not seem to have much effect on the market prices.

Large quantities of commercial fertilizer are applied to the groves. Irrigation is considered inadvisable, especially with the salty sulphur water obtained from the artesian wells.

The general method of grove management is to allow weeds to grow and then to cut them down and put the material around the

trees as a mulch after working the ground around the trees with the hand hoe and applying fertilizer. After this the land between the trees is thoroughly worked with a disk harrow.

The guava thrives on this soil and a considerable quantity is produced, the product being in demand for making jelly. Several tropical and subtropical fruits are grown about the dwellings, such as date palms, mangoes, avocados, papaws, or papayas, etc. These are not grown except for home use. Before the freeze pineapples were grown extensively on this soil.

The value of this soil type depends upon its location and improvement. Prices ordinarily range from $15 to $150 an acre. Riverfront land suitable for building sites is held at still higher figures.

Portsmouth Series.

The Portsmouth soils are dark gray to black and are high in organic matter. The subsoils are light gray to mottled gray and yellow, and the heavier members are always plastic, though usually carrying a noticeable proportion of sand. These soils are developed in flat to slightly depressed, poorly drained situations, and require ditching before they can be used for agriculture. The series is most extensively developed in the flatwoods, or the low, seaward portion of the Coastal Plain lying east of the Mississippi River. Scattered areas are frequently found in the poorly drained depressions of the higher Coastal Plain country.

PORTSMOUTH SAND.

The Portsmouth sand, in its typical development, varies from a dark-gray to black medium sand, which grades below through gray sand into nearly white sand. The surface material has a loamy feel, owing to its high content of organic matter. In some places the organic matter is present in such quantity that the surface soil is rather a mucky sand, but such areas occur only in spots. The depth of the dark-colored surface layer is from 8 to 15 inches. This soil is always underlain either within the 3-foot section or not far below it by what is known as "hardpan." Quite frequently the hardpan layer is encountered at about 15 to 24 inches beneath the surface. This hardpan stratum varies in thickness from an inch or two to 8 or 10 inches or more. The upper portion is usually black or brownish black, changing below to the color of coffee grounds, and gradually becoming somewhat lighter in color and looser in structure until it passes into light brownish or white sand. Generally the soil auger penetrates the hardpan easily, but there are areas where this is not possible, the layer being especially thick and very compact and hard.

The subsoil of this type is compact and more or less water-logged. When dug into in a wet condition the sand runs like quicksand.

The Portsmouth sand is extensively developed in each of the three counties embraced in the area surveyed. It is found in the flatwoods beyond the coastal ridge of the mainland and there is a considerable body on Merritts Island. The type does not occur on the cordon of islands next to the ocean. The largest bodies occur in the flat, poorly drained lands known as "flatwoods," but small areas or strips are found on the forelands of the mainland.

It is typically forested with pine (*Pinus caribbea*), which in Palm Beach County and up into St. Lucie is rather sparse and gnarly and twisted. Farther north in Brevard County this pine is displaced by the longleaf yellow pine, which is of a larger growth. The undergrowth consists of saw palmetto, together with gallberry, huckleberry, a good sod of wire grass, and also, quite frequently, a thick growth of broom sedge in the more open spots.

The type also occupies broad, shallow depressions known as "prairie" or "prairie lands," which are treeless or in which trees occur only in small areas. Water stands in the depressions much of the year, but they are usually dry at some time in dry seasons. Water-loving grasses are the main growth, with such plants as St. John's wort and St. Andrew's cross and some others, and in better-drained parts broom sedge grows luxuriantly. During the spring and summer these prairies and levels afford comparatively good pasturage. The Portsmouth sand is also found in the long, narrow troughs or sloughs known as "savannas." These are covered much of the year with water and to much greater depth than the prairies. Water-loving grasses, with other aquatic plants, constitute the growth.

The Portsmouth sand is of marine sedimentary origin. Since the recession of the sea it has existed at least for considerable periods under lacustrine and very poorly drained conditions. The surface is now barely above the permanent water table, the subsoil being usually saturated, and intermittently the surface is covered with water during heavy rainy spells, which, however, does not stand long enough to prevent the growth of pines and palmettos, except in the shallow prairie and savanna depressions. The type stays wet enough to favor the accumulation or retention of organic matter formed upon the surface.

Drainage is necessary for the reclamation of the land. Open ditches are employed for this purpose. While the country back of the coastal ridge is low and flat, levels run by engineers show that the flatwoods are considerably above sea level. To drain much of the land effectively the canals must be opened to the sea or streams flowing into the sea. This of necessity will entail considerable expense. Some of these areas extending back beyond the limits of the survey in a number of localities are being reclaimed, dredges

being used to cut the main ditches and larger laterals, the smaller division ditches in the farms being dug with hand tools.

Thus far only little of the Portsmouth sand occurring in the area surveyed has been developed for cultivation. When thoroughly drained the soil is suited to the production of a variety of crops, especially vegetables. In growing crops on this land considerable expenditures are made for commercial fertilizer, as its natural productiveness is not great. Of the trucking crops tomatoes seem to succeed best, but cucumbers, onions, lettuce, celery, peppers, and eggplant are all successfully grown.

Some citrus fruit is now produced and more groves are being set out. It is not an ideal soil for these fruits, but where ditched and the soil hilled up to place the trees above the water table and high-water conditions, the hardpan being first broken if necessary, orange trees make a thrifty growth.

The value of land of this character ranges from $10 to $60 an acre, depending upon location and condition as regards drainage.

Portsmouth sand, hammock phase.—The hammock phase of the Portsmouth sand differs from the typical flatwoods Portsmouth sand in having a higher content of organic matter in the surface soil and generally a greater average depth to the light-colored underlying sand, also in supporting a hammock growth of hardwood trees and a heavy jungle-like undergrowth. It is found in drainageway depressions and sloughs and on forelands along the shore. It consists of a black more or less mucky medium sand to a depth of 12 to 24 inches, underlain by grayish compact sand. Frequently there occurs in the soil section a black to brown hardpan layer, usually at about 12 to 24 inches beneath the surface, but sometimes below 36 inches. The mucky character or organic-matter content varies. On the edges of the sloughs or hammocks the soil approaches that of the typical Portsmouth sand in being more sandy, but toward the middle of depressions it becomes more mucky, and often a shallow muck surface is present. Thus the phase represents an approach toward the condition of true Muck. Another variation is represented by the occurrence of Muck at about 24 inches or more beneath the surface. Also, in places, there is a substratum of rock. These occurrences, however, are small. If sufficiently extensive they would have been mapped as some other soil type.

The areas of the hammock phase are small, occurring in narrow bodies throughout the mainland strip. The total extent is not very large.

The position of the areas denotes poor drainage conditions, but often they can be drained by merely running a ditch along the lowest part of the depressions. When put in condition for cultivation this class of land is quite productive. The organic matter,

besides being in greater quantity, seems to be more lasting, not disappearing rapidly upon cultivation and exposure to the sun, as in the case of the flatwoods areas. It will produce the same crops as the flatwoods, is especially desirable for trucking, and brings better results with the same or less fertilization. Citrus trees, especially grapefruit, where drainage is effective, do at least fairly well on this phase of the type.

The forest growth, as stated before, is heavy and contains some hardwoods. Oaks of large size and cabbage and saw palmetto are abundant. The saw palmetto, while scattered, attains a larger size than in the flatwoods. The jungle growth, which is often thick and heavy, includes myrtle, swamp huckleberry, and other shrubs and vines. The value of these areas of hammock is high.

PORTSMOUTH FINE SAND.

The Portsmouth fine sand is similar to the Portsmouth sand except in texture. The surface soil consists of a dark-gray to black, rather fine sand, containing enough organic matter to give it a somewhat mucky character. In depth it ranges from 8 to 15 inches. The soil is underlain to a depth of 36 inches or more by compact grayish fine sand. As in the Portsmouth sand, a dark-colored hardpan layer is frequently encountered at 12 to 24 inches, or at any point between 12 and 36 inches. The subsoil is even more like "quicksand" than that of the coarser Portsmouth sand, with a strong tendency to flow when exposed. In the hand the material is loose and incoherent.

This type was mapped only in St. Lucie and Brevard Counties. It is extensively developed, however, inland beyond the limit of the survey; it also occurs in Palm Beach County. The largest tract within the area surveyed occurs on Merritts Island. It forms flatwoods, prairie ponds, and "savannas." To reclaim this soil for cultivation it is necessary to establish artificial drainage by canalization. Properly drained, the soil is suited to the same crops as the Portsmouth sand, and is a little more productive on account of its finer texture, greater susceptibility to improvement, and higher moisture-holding capacity.

It supports the same growth as the Portsmouth sand, that is, longleaf pine, saw palmetto, gallberry, wire grass, and broom sedge. It is recognized as a better soil than the latter. Very little of it is under cultivation.

Portsmouth fine sand, hammock phase.—There occur hammock areas of the Portsmouth fine sand corresponding to those of the Portsmouth sand. The surface soil consists of dark-gray to black, rather loamy or mucky fine sand, underlain at depths of 8 to 20 inches by grayish to white fine sand, with frequently a hardpan layer within the 3-foot section.

The areas are small and confined to the mainland and to Merritts Island, in Brevard County. The total extent is small.

As with the Portsmouth sand, some small spots were included with the hammock phase of this type where the underlying material consists of a marly clay of grayish color. While the areas of this phase of Portsmouth fine sand are small, they are of considerable value and by thorough drainage can be made to produce even better crops than the corresponding phase of the Portsmouth sand.

Plummer Series.

The Plummer soils are gray and frequently mottled with dark-brownish colors and underlain at a depth varying from 8 to 20 inches by compact, light-gray material more or less mottled with streaks of brown and yellow. The lower portion of the subsoil usually consists of sandy clay or sticky sandy material, including pockets or layers of yellowish plastic sandy clay. The soils are derived from reworked Piedmont-Appalachian material. They are nearly always in a wet condition, water frequently standing on the surface after heavy rains. A scattered growth of cypress, pine, and occasionally cabbage palmetto constitute the principal tree growth. This series is typically developed in the flatwoods region of the South Atlantic and Gulf Coastal Plain.

PLUMMER SAND.

The Plummer sand to a depth of 4 to 6 inches consists of a gray to brownish-gray or dingy-gray sand, underlain by material of the same texture and of a dingy-gray or whitish color. This quickly grades into a white sand which extends to a depth of 36 inches or more. The whole 3-foot section of this type is quite compact and more or less water-soaked.

Areas of the Plummer sand occupy shallow and flat depressions in the flatwoods. They correspond to what is known locally as "prairie" or "sand ponds." They are devoid of trees except in spots, in which a few pines are found. These trees are found on higher spots, and with them occur saw palmetto, gallberry, and some wire grass. In the ponds or prairies the growth is mainly a thickly matted grass rather peculiar to the type, together with some other grasses and sedges.

The Plummer sand is closely associated with areas of Portsmouth soils, but the drainage conditions have not favored the equal accumulation of organic matter in the soils of both these series, which is the principal reason for their separation. While the Plummer areas are covered at frequent intervals by rain water, the conditions do not cause an excessive growth of vegetation or the preservation of organic remains in the soil. The water stands long enough to inhibit most

growths except the grasses. When the areas are dry, being unshaded, they are exposed to the direct rays of the sun and the processes of decomposition are rapid.

Relatively large areas of the Plummer sand lie in Palm Beach County in the flatwoods section, and in the flatwoods west of Cocoa, in Brevard County. Besides these there are some small bodies scattered throughout the area of flatwoods as small prairies and sand ponds.

This soil is not used for any agricultural purpose. With thorough drainage, irrigation, and heavy fertilization it could probably be made moderately productive.

Palm Beach Series.

The Palm Beach soils are characterized by the brown to dark-brown color of the surface material, and by the grayish or grayish to brownish color and loose shelly sand subsoil. These soils occupy flat to hummocky or low ridgy areas near the ocean in Florida. The material forming them represents sand which has been subjected to the attrition of waves and tides, mingled with fragments of sea shells, and finally blown up above the reach of sea water and fixed or held in place by vegetation. The brownish color is due to the accumulated organic matter. The series may be considered as intermediate between Coastal beach and the white highly siliceous sands farther inland.

Two types of this series are mapped in the Indian River area.

Palm Beach sand.

The soil of the Palm Beach sand consists of a brown or grayish-brown heavy sand or loamy sand, underlain at 6 to 12 inches by grayish sand or speckled grayish and brownish sand, the speckled color being due to the presence of different colored fragments of sea shells. A common feature is a snuff-brown compact sand resembling hardpan in the subsurface. The color of this stratum is due to staining by brown organic matter leached from above. Areas of the Palm Beach sand form a series of parallel ridges or undulations bordering the Coastal beach, and lying between the latter and the flat-lying lands farther inland. It occurs throughout the length of the islands, interrupted in a few places by soils composed almost wholly of siliceous sand.

Next to the Coastal beach and within limits of influence by salt-water spray and when frequently burned over, saw palmetto thrives and forms a dense growth to the exclusion of other growths, but away from the spray and where not disturbed the soil supports a thick hammock vegetation of tropical to subtropical character, including such plants as coconut, rubber trees, live oak, cabbage palmetto,

and many other trees and shrubs. The coconut thrives on the soil, fruiting well and continuously when not injured by frost, which is of very rare occurrence. This soil will grow most vegetables, especially with fertilization. String beans, the first truck crop grown in this region, were grown on it, and they are still produced in St. Lucie County on this soil (see Pl. IV, fig. 2). The most important development has taken place in the vicinity of Quay, where tomatoes are the leading crop. The Palm Beach sand is naturally more productive than the white siliceous sands of the mainland, as is readily seen by a comparison of the natural vegetation.

Wherever improved the value of the Palm Beach sand is high, as compared with other soils of the area.

The results of mechanical analyses of samples of the soil and subsoil of the Palm Beach sand follow:

Mechanical analyses of Palm Beach sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
261029	Soil	1.2	21.4	44.6	27.5	1.0	2.8	1.5
261030	Subsoil	4.8	29.2	36.6	23.6	1.2	2.4	2.5

The following samples contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 261029, 7.34 per cent; No. 261030, 47.34 per cent.

PALM BEACH FINE SAND.

The surface soil of the Palm Beach fine sand, ranging from 8 to 15 inches in depth, varies from grayish-brown to brown or nearly black loamy fine sand containing much organic matter. The subsurface is usually a snuff-brown or yellowish-brown loamy sand. This passes abruptly into a grayish or speckled grayish and brownish fine sand, which in the lower part of the 3-foot section usually becomes coarse, owing to the fragments of shells present. In places, particularly in the troughs and lower situations next to the marshes, marly material is found in the lower part of the profile.

The distinguishing characteristic of the Palm Beach fine sand is the presence of finely divided shell fragments mixed with the siliceous sand. Generally the quartz sand particles predominate in the surface soil and the shell fragments in the subsoil.

The Palm Beach fine sand is confined to the barrier islands and lies between the Coastal beach and the mangrove swamps along the sounds and lagoons. The areas occur in belts or strips and are not continuous, being interrupted in places by areas of the sand of the series. It frequently occurs as narrow ridges alternating with ridges of Palm Beach sand too narrow to map separately.

As a whole the drainage of the type is good and in places excessive, as water readily passes through the soil and subsoil. Where it borders the low hammock areas it is poorly drained.

Next to the ocean the type supports almost exclusively a thick growth of saw palmetto, but farther back it is covered by a hammock growth of tropical and subtropical hardwoods and cabbage palmetto. The jungle is luxuriant and dense.

The areas far enough removed from influence of salt spray are, when cultivated, devoted to the growing of string beans. This crop does well on this soil.

The average results of mechanical analyses of samples of the soil and subsoil of this type are here given:

Mechanical analyses of Palm Beach fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
261050, 261064.....	Soil.....	0.0	1.7	12.3	77.9	5.5	1.4	0.3
261051, 261065.....	Subsoil.....	.2	2.9	13.4	75.4	5.7	1.2	.8

The following samples contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 261051, 9.09 per cent; No. 261065, 22.50 per cent.

Parkwood Series.

The distinguishing feature of the soils placed in the Parkwood series is the gray to white lower subsoil of marl. The soils are grayish to grayish-brown in color, with subsoils of grayish-brown to yellowish sandy clay to heavy clay loam in the upper portion, resting upon marl or other whitish calcareous material within the 3-foot section.

PARKWOOD SAND.

The surface soil of the Parkwood sand is a light-brown to dark-brown sand to loamy sand carrying considerable organic matter and shell fragments. The depth of the surface ranges from 6 to 12 inches. Beneath this is usually found snuff-colored or yellowish-brown loamy sand for a few inches and then whitish shell marl, the upper part usually somewhat stained by organic matter leaching from overlying material. This marl varies from a mass of partly decaying shells to marly sandy clay or marly clay, with a varying content of shell fragments, and continues to depths ranging from about 15 to 36 inches, at which depths a consolidated rock, coquina, is encountered. This generally is only a few inches thick, and beneath is found a soft, calcareous, shelly rock.

The land is low, lying next to Tidal marsh or mangrove swamps, and is cut by irregular sloughs. The soil is quite dark or black in the lower poorly drained situations. On the higher interslough areas the color of the soil and subsoil is in places slightly reddish or yellowish and coquina is not encountered within the 3-foot section. Also there are many spots where the soil is grayish to yellowish-brown at the surface.

The type is closely related to the Palm Beach sand, lying next to it but at lower levels, and differing chiefly in the presence of a marly subsoil.

The Parkwood sand is found only on the barrier island along the coast and its extent is small, consisting of narrow strips in St. Lucie and Brevard Counties. It is low-lying and in part poorly drained, especially in the lower lying hammocks, which are subject to inundation by salt water during gales. The areas in St. Lucie County are cut up irregularly by mangrove sloughs, the interslough areas being slightly ridgy or undulating. The typical soil has good drainage; that is, all of it is well drained except the depressions and very low strips next to wet soils. On the other hand, moisture is retained in sufficient quantity during ordinary seasons, except in the case of the very lightest phase and those spots where the coquina comes near the surface. In long dry spells the soil becomes somewhat droughty. The marl is always moist and often saturated.

The land supports naturally a heavy hammock growth. Live oak, magnolia, and cabbage palmetto are the principal trees.

The growing of string beans on this soil has met with considerable success. Only one crop is grown during a season, and no rotation of crops is practiced, but weeds, mostly introduced species, take possession of the land that has been used for beans for a number of years. These grow luxuriantly and are of some benefit when turned under. The soil is considered productive, but in growing beans an application of 1,000 pounds of high-grade commercial fertilizer, such as a 6–5–8 mixture, is usually made. About 150 crates or hampers of beans to the acre is considered a good average yield. Tomatoes do fairly well on this soil, but potatoes are said not to succeed, and, except on the low, moist, dark-colored spots, cabbage is not a profitable crop.

The value of the land is high and little is on the market. Land has been sold for $200 or more an acre.

In the following table are given the results of mechanical analyses of samples of the soil and subsoil of the Parkwood sand:

Mechanical analyses of Parkwood sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
261027	Soil	0.4	28.9	37.6	28.6	0.6	1.7	1.5
261028	Subsoil	.9	25.1	34.6	29.0	1.2	3.2	6.0

The following samples contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 261027, 0.76 per cent; No. 261028, 16.14 per cent.

PARKWOOD FINE SAND.

The surface soil of the typical Parkwood fine sand consists of 6 to 12 inches of dark grayish to black fine sand high in organic matter. The subsoil consists of drab to grayish fine sand that rests upon underlying limestone at varying depths, usually being found from 8 to 24 inches beneath the surface. The presence of the rock distinguishes this soil from the Portsmouth fine sand. There are variations in which the subsoil is of a yellowish or greenish-yellow color or drab streaked with yellow, and occasionally some clay is present, giving the lower subsoil a sticky nature. There also are spots in which a thin layer of marly clay or marl overlies the rock. As mapped the type includes spots of Parkwood fine sandy loam and Portsmouth fine sand.

A small narrow strip is found in St. Lucie County on the mainland, where it occurs as a gradational strip between the Parkwood fine sandy loam and the Portsmouth fine sand of the flatwoods. There is a similar area on Merritts Island west of Sykes Creek. The most important development of the type is east and northeast of Courtenay, where it occurs as islandlike patches along the areas mapped as submerged marsh.

The characteristic vegetation consists of mixed pine and cabbage palmetto, with some live oak, and an undergrowth of saw palmetto, broom sedge, and wire grass. The areas east and northeast of Courtenay support a dense low growth of saw palmetto and scrub oak. There is a scattering of pine on some of these areas and also some cabbage palmetto.

None of the type is cleared and under cultivation. It would not be as strong as the other Parkwood soils, not having the clay substratum, and crops would likely suffer from lack of moisture. The vegetation indicates a rather inferior soil, yet it is a more productive type than the Norfolk sand when the limestone does not come very near the surface.

Mechanical analyses of samples of the soil and subsoil of the Parkwood fine sand follow:

Mechanical analyses of Parkwood fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
261019	Soil	0.1	0.6	2.8	86.4	3.8	4.6	1.7
261020	Subsoil	.3	.4	1.6	89.2	3.1	3.2	1.3

PARKWOOD FINE SANDY LOAM.

The Parkwood fine sandy loam is a rather variable soil. The soil typically consists of dark-gray to black fine sand or loamy fine sand, underlain at about 8 to 15 inches by grayish to drab fine sand to fine sandy loam, often mottled or streaked with yellow or greenish yellow. This grades below into white or mottled drab and yellowish marly clay or fine sandy clay. In places the whitish clay grades into yellowish or mottled yellowish and drab clay, while in other places the reverse is true. Some included spots have only a mottled yellowish and drab clay subsoil. This clay stratum usually rests upon limestone at depths ranging between 12 and 36 inches, the average being 18 or 20 inches. In many places the rock is not encountered within the 3-foot section, the rock surface being very uneven. In places the subsoil runs into a gray clayey marl for a few inches before reaching the rock. Some spots are found in which the subsoil is a golden-yellow fine sand with clayey lenses, this resting upon rock. Also, patches are found where the rock outcrops, with a few loose fragments scattered over the surface. Patches of Portsmouth fine sand too small to map are included.

The largest development of the type is on Merritts Island in Brevard County, where it occupies a broad belt through the central-north portion, with some scattering small areas. The type also occurs in St. Lucie County. The Parkwood fine sandy loam occurs as low, nearly level areas, with occasional slight depressions and faint hummocks. It usually lies next to the Tidal marsh and is but slightly elevated above it.

The strips on the mainland and along savannas of Merritts Island support a mixed growth of longleaf pine and cabbage palmetto, the latter growth making the land stand out conspicuously from the pine flatwoods. Open spots and prairies have a growth of switch grass and other grasses which make a good growth for pasturage. Clumps of cabbage palmetto occurring on slight hummocks dot the prairie areas. In the more open pine woods wire grass and broom sedge afford some grazing. The main area and the associated small ones support a thick growth of saw palmetto and some cabbage palmetto, along with a particularly thick growth of evergreen oak scrub. This largest area is known locally as "the scrub." The vegetation on it is so thick as to be almost impenetrable.

Some of the land has been taken up in homestead entries, and is being cleared for cultivation. With drainage and control of excess water the land should be productive. Some of the higher parts can be used without much drainage, although clearing will be expensive on account of the heavy growth. This soil should, with proper treatment, produce successfully a number of vegetables and forage

crops. From the success had on the clay loam of the series, citrus fruits should do well.

Below are given the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of the Parkwood fine sandy loam:

Mechanical analyses of Parkwood fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
261014	Soil	0.0	0.5	1.6	86.0	4.8	4.8	2.0
261015	Subsoil	.0	.1	.9	87.7	5.9	3.3	1.9
261016	Lower subsoil	.0	.1	.4	75.1	5.6	7.3	11.9

PARKWOOD SANDY LOAM.

The surface soil of the Parkwood sandy loam typically consists of a black, loamy, medium sand containing usually much organic matter and varying in places to a rather mucky sandy loam or loamy sand. The depth of the surface soil ranges from 6 to 12 inches. The subsoil varies in both color and texture. The upper part is usually a drab or grayish medium sand, but this soon becomes sticky or clayey below and changes in color from drab to greenish or yellow or mottled drab and yellow or greenish yellow. Generally plastic, sandy clay of whitish drab or mottled drab and yellowish color is found in the lower subsoil. This usually rests upon limestone at about 24 inches, but the rock stratum is quite variable in depth and may be found within 15 inches or less of the surface, or it may not occur at all within the 3-foot section. Frequently in small spots the sandy clay is replaced by a gritty, whitish, clayey marl, lying just above the rock. Quite frequently the surface soil and subsoil are similar in all respects to the Portsmouth sand, with the exception that there is a clayey lower subsoil an inch or two thick overlying the limestone. These and other variations occur within small distances, making the land quite variable.

The Parkwood sandy loam is found as long strips from about one-eighth to one-fourth mile wide in St. Lucie County on the mainland between the flatwoods and Tidal marsh and on Merritts Island between the prairie and flatwoods. It is not an extensive soil type. It occupies a low-lying position with poor drainage. Its typical place of occurrence is between the Tidal marsh and flatwoods, and its elevation is intermediate between them. The surface is flat, with slight depressions where grass grows instead of trees, and which are occasionally deep enough to hold water most of the year.

The type supports a mixed growth of longleaf pine and cabbage palmetto, some live oak and tall oak scrub, clumps of large saw

palmetto, myrtle, and other scrub growth. There also occur small open spots in which the growth is "switch grass," "bunch grass," or "sword grass." These grassy or prairie spots are small and are covered by water a considerable part of the year. The greater proportion of the type is subject to inundation by salt water at times of heavy gales and high tides, but these inundations last only for brief periods. At times of heavy rainfall, also, water stands upon the surface, the land being low and the run-off slow. The underlying clay, which lies barely above the water table, retards drainage by percolation; consequently much of the excess moisture must escape by evaporation. The drainage of this land can be improved by ditching or by ditching and diking. Pumping may be found necessary for the lowest areas. Provided drainage could be effectively accomplished, this soil unquestionably could be used for the production of a number of vegetables, forage crops, and for citrus fruits, especially certain varieties of grapefruit. None of the Parkwood sandy loam is under cultivation.

PARKWOOD CLAY LOAM.

The Parkwood clay loam typically consists of black or dark-drab clay loam to sandy clay loam, underlain at about 3 to 8 inches by light-drab to white clay of a highly calcareous nature. Limestone is reached at almost any depth from about 5 to 24 inches.

This soil occurs as rather small, widely scattered areas lying slightly above areas of its prairie phase. It supports a heavy hammock growth consisting chiefly of live oak and cabbage palmetto. Decaying vegetation has given rise to a high organic-matter content. These hammock areas are rather low and hummocky, with narrow irregular sloughs cutting them at intervals. In the sloughs a heavy hardwood growth, principally the swamp maple, is found. The surface material of the sloughs consists of black muck of varying depth, from a few inches to more than 36 inches, underlain by limestone.

On the higher situations there are some spots of sand of dark-gray to black color, varying from a mere surface veneer to several inches deep. Also, the subsoil of some areas is affected by the presence of sand, being more or less friable. There are some included patches of Portsmouth sand and Muck.

The largest areas are found on Merritts Island. These stand out prominently in the landscape. The oaks growing on them are large and thick, and the cabbage palmetto is taller than usual. Some magnolia, bay, and other trees and a hardwood undergrowth are present. All these, with the numerous climbing vines, make the growth thick and in places almost impenetrable.

Much of the type is sufficiently high to be effectively drained by ditching, although there are some scattered areas that can not be thus drained. In such wet places citrus trees are planted on mounds constructed to obtain better drainage in the immediate site.

These hammocks when sufficiently elevated are highly esteemed for citrus-fruit growing and some of the largest groves in the area are found upon them in the interior of Merritts Island. Small bay hammocks of the type on the mainland are devoted to this use.

Orange trees make a thrifty growth on this soil even without fertilization, although they do best where fertilizers are used. The fruit of both the orange and grapefruit is of good quality, with bright, clear skins, grading as "brights." The trees bear heavily, and the groves usually have been profitable.

The value of these hammocks is high and as a rule they are not on the market.

Parkwood clay loam, prairie phase.—The surface soil of the Parkwood clay loam, prairie phase, to an average depth of 5 or 6 inches, consists of black to drab clay loam or sandy clay loam. In places a thin layer of sand or sandy loam is found on the surface. The subsoil is white calcareous (marly) clay or drab clay which grades into white clay or marly clay. Limestone is encountered at varying depths ranging from a few inches to about 28 inches, the average being near 18 inches. In some of the lower positions next to Tidal marsh the subsoil is a soft puttylike clay of drab color or drab mottled with yellow. This is a dense soil which when wet is very sticky and plastic. Both the soil and subsoil are highly calcareous in composition, effervescing strongly with acid.

The areas of Parkwood clay loam, prairie phase, are confined to Brevard County, occurring on the peninsula next to the Tidal marsh and in some of the savannas. The largest area is in the central part of Merritts Island. The total extent, however, is small.

The soil is typically flat prairie land or savanna land, supporting a thick growth of switch or sword grass, without any trees except occasional clumps of cabbage palmetto and live oak on included sandy spots. The areas on Merritts Island are called "high prairie," but these lie only slightly above the wet prairies mapped as submerged marsh. Within the type there are some shallow sloughs supporting in addition to the switch grass some water-loving plants, such as sagittaria.

The areas of this phase are being taken up in homesteads, and preparations are being made to put them under cultivation. This can be done readily, as beyond burning the grass no clearing is necessary. The calcareous character of the land would indicate a soil of high productiveness. Such heavy truck crops as tomatoes

and cabbage should succeed. Cabbage of excellent quality is grown on the same soil in the vicinity of Coleman, Fla. Large yields of forage crops, such as velvet beans and beggarweed, probably can be grown. The main problem with this soil is to control the drainage. Because of the dense, retentive character of the soil, rain water stands on the surface. Areas lying too low to be thoroughly drained by open ditches may need dikes and pumping plants. This soil during protracted dry spells would likely prove droughty unless kept well pulverized and supplied with vegetable matter, inasmuch as such heavy clay is inclined to bake and assume a condition favoring rapid loss of moisture by evaporation.

The average results of mechanical analyses of samples of the soil and subsoil, and the results of a mechanical analysis of a sample of the lower subsoil of the prairie phase are given below:

Mechanical analyses of Parkwood clay loam, prairie phase.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
261011, 261033	Soil.....	1.3	12.6	13.1	20.7	2.7	27.9	21.3
261012, 261034	Subsoil.....	2.0	10.1	7.9	16.2	4.0	31.6	28.4
261013.....	Lower subsoil...	1.6	17.2	17.0	28.9	4.5	13.3	17.3

The following samples contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 261011, 10.57 per cent; No. 261012, 30 per cent; No. 261013, 65.55 per cent; No. 261033, 83.64 per cent; No. 261034, 82.27 per cent.

GAINESVILLE SERIES.

The soils of the Gainesville series are prevailingly gray in color, with brownish-colored subsoils, which carry calcareous clay or partly weathered limestone within the 3-foot section. These soils are sometimes locally known as "chocolate hammock land," or "second hammock land," and are developed most extensively in the rolling uplands of the Florida Peninsula. The native timber growth consists of large scattering pines, interspersed with hickory and several varieties of oak. The natural drainage is good.

Two types in this series, the Gainesville sand and Gainesville loamy fine sand, occur in the Indian River area.

GAINESVILLE SAND.

The soil of the Gainesville sand typically consists of a brownish-gray to brown or slightly reddish brown loose sand to rather loamy sand overlying red to brownish-red or yellowish-brown sand to loamy sand. The depth of the sand ranges from a mere veneer of 3 or 4 inches to as much as 2 feet. The subsoil is variable in depth. The type rests upon a very uneven limestone platform, and the rock may

be within a few inches of the surface or much deeper than the 3-foot section, as seen in places where the stone is being quarried. The average depth to rock is about 24 inches.

There are in this type a good many spots of a decidedly loamy sand, dark-brown to yellowish-brown in color, grading below into a lighter shade of yellowish-brown or into reddish-brown loamy sand. The surface soil carries considerable organic matter, especially in the lower situations. Also in some of the lower places there is occasionally found a thin stratum of clay of greenish-yellow, reddish-yellow, or mottled yellowish and brownish color overlying the bed rock. Those places where clay is found are mostly in the vicinity of Bonaventure, in Brevard County, and of Georgiana, on Merritts Island.

In places the soil mapped under this heading varies considerably within narrow limits. Spots of the typical brown soil with reddish subsoil are found in intricate association with spots of yellowish sand underlain by orange-yellow sand, or of gray to white sand with yellowish to mottled yellowish and grayish sand, with still other variations of little importance.

The principal areas of the Gainesville sand are those in the vicinity of Cocoa, between Titusville and Bonaventure, on Merritts Island, and as narrow strips between Palm Beach and Hobe Sound.

The type is largely residual from the underlying calcareous rocks. The lighter colored sand of the surface portion probably consists chiefly of originally unconsolidated sand, but the reddish subsoil material appears to be largely residual from limestone.

The type is small in extent, but is important in that most of it is utilized, it being held in high esteem because of its productiveness and response to fertilization. It will grow most of the crops produced in this section, although it is a well-drained and rather dry soil on which crops are liable to be damaged by protracted dry weather. String beans do well on it, and other vegetables, with the exception of celery. Strawberries and onions do exceptionally well. The type is also devoted to citrus-fruit culture, the trees making thrifty growth and giving good yields of good quality. The fruit "russets" on this soil, but this apparently does not affect the selling of it. The trees are given liberal applications of fertilizers.

The most of this soil has a high value, as it lies along the shores and is desirable for residence sites.

GAINESVILLE LOAMY FINE SAND.

The Gainesville loamy fine sand consists of a loamy fine sand without important textural change within the soil section, except that the immediate surface few inches has a more loamy character than the subsoil on account of a higher content of organic matter.

The usual color of the soil is brown or dark brown to almost black, while the subsoil is yellowish brown to reddish brown or dark red. In places the surface is brownish gray, and in those spots the sand is not so loamy.

This material overlies rock at depths ranging from a few inches to about 24 inches. The average depth is close to 15 or 18 inches. The soil is loose and easily tilled, except where the rock comes close to the surface and interferes with the use of implements.

The extent of the type is small. It is found in a narrow strip on the mainland in the vicinity of Vero in St. Lucie County and on the lower end of Merritts Island in Brevard County. It is an open, porous soil and has good to excessive drainage. It is evidently residual or largely so from limestone or from coquina. The rock platform is very uneven and the upper surface of the rock is very hard.

This soil is considered productive. Where cultivated it is devoted chiefly to growing string beans. There are some thriving citrus groves on Merritts Island areas and they are giving good yields of a good quality of fruit.

The results of mechanical analyses of samples of the soil and subsoil of the Gainesville loamy fine sand are given below:

Mechanical analyses of Gainesville loamy fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
261023	Soil	0.6	12.0	16.0	57.7	2.1	6.3	5.0
261024	Subsoil	1.0	13.9	15.0	55.6	1.8	3.5	9.0

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 261024, 2.39 per cent.

Miscellaneous Material.

COASTAL BEACH.

Coastal beach comprises a continuous narrow strip of sand which rises from the edge of the ocean to a low hummocky ridge or a series of low ridges with intervening shallow troughs. The width of these strips varies from about 100 to 500 feet. The face of the slope from the water's edge up to the line of vegetation is smooth and even, but above this point the surface is usually hummocky and quite uneven. In places the surface is continually subject to change by the winds, this being particularly true where vegetation has not taken hold.

The material is composed of mixed siliceous sand particles and shell fragments, the proportion of each varying from place to place.

The sand also varies from rather coarse to fine. It is loose and incoherent. On account of its loose structure and the salt spray that falls over and upon it, vegetation is absent, or almost so, along the immediate beach. The characteristic growth of the upper portion is sea grape, coarse sand grasses, saw palmetto, and Spanish dagger. This land is of no agricultural value.

MUCK.

Muck consists of vegetable matter in varying stages of decomposition, mingled with varying proportions of mineral matter. The surface material is black to dark brown and finely divided. On areas of deeper deposits this surface soil overlies brown fibrous material known as Peat. The depth of the Muck varies from a few inches to several feet, depending upon where it is found. The decomposing vegetable matter respresents the remains of plants laid down in the presence of water, and more or less preserved by the water through its action in retarding oxidation. The Muck varies according to the vegetation from which its organic portion is derived.

In addition to the typical Muck, which is largely covered with saw grass, two phases were mapped, the hammock phase and the mangrove swamp phase.

The organic matter in the typical or saw-grass Muck has been formed largely from the growth and decay of that plant. As mapped the type includes considerable areas of Peat which could not be satisfactorily separated under existing conditions.

The areas of the typical Muck are found in long, narrow sloughs in all parts of the area and in larger saw-grass ponds and lakes. In these occur open places of water where water lilies, sagittaria, rushes, and other aquatic plants flourish. The saw-grass areas are low-lying and are covered throughout the year with varying depths of water, according to season. The water is entirely fresh. Only a small area of this saw-grass Muck near West Palm Beach was seen under cultivation during the survey. It requires drainage for reclamation, and for the most part this would be difficult and expensive. When thoroughly drained it is a valuable soil for the production of vegetables.

Muck, hammock phase.—The material of the hammock phase of Muck consists of finely divided black organic matter mixed with some sand. Only in the deeper portions is the brown fibrous peat found. The depth ranges from about 8 inches to more than 3 feet, the greater part being about 24 inches in depth. Beneath this is found brownish-gray to almost white sand.

Areas of this phase occur as drainageway depressions in the flatwoods. The shallowest portion lies along the edge and the deepest

in the middle of the depressions, where Peat is also liable to occur. It supports a heavy hammock growth consisting chiefly of live oak, swamp maple, bay, myrtle, and cabbage and saw palmetto. In places marly material underlies the Muck, but such areas are small and scattered. Although the material exists under poor drainage, being saturated throughout the greater part of the year, it is not always covered with water, as is the typical Muck, and can be more easily and cheaply drained. The clearing of the heavy hammock growth, however, entails considerable expense. This phase of Muck is valuable for vegetables. That portion having marl in the subsoil or substratum is particularly productive, giving excellent yields of a variety of vegetables. Fertilization is necessary for best yields. Under cultivation the organic matter gradually diminishes and the surface soil becomes more sandy.

Muck, mangrove swamp phase.—The Muck, mapped as the mangrove swamp phase, includes black to brownish Muck ranging in depth from about 2 to several feet and underlain by different materials, in places a brownish colored sand, in other places black clay, and in still others marl or limestone. The freshly exposed material has a strong odor of hydrogen sulphide.

This phase of Muck occurs in low areas forming the inner fringe of the barrier island and the shore of the mainland along the sounds and lagoons. It is subject to tidal inundation with salt water or influenced by salt water sufficiently to make the material too salty for the growth of other than salt-tolerant plants. The salt or brackish water is forced over these flats by normal tides and by wind tides. There is a characteristic thick growth of red mangrove, and some black mangrove, and in open spots salt weed. This Muck has no present agricultural value and would be difficult to put in a condition for crops, owing to the expense of reclamation. Protected from inundation and drained the material undoubtedly would soon assume a productive condition and be suitable for growing vegetables and forage crops.

SWAMP.

An area of Swamp occurs in Palm Beach County, and this is the only area found in the survey. This area supports a growth of cypress, in part a dense growth excluding all other vegetation, and elsewhere clumps of cypress interspersed with areas of water or water with saw grass and water lilies. In places the stand is rather thin or scattering. The trees are not large, being rather slender and short. The area is covered by water from a few inches to several feet deep, which varies in depth according to season and rainfall. In prolonged dry spells some parts may become dry or nearly so, but as a usual thing water covers the surface throughout the year. This soil varies considerably, consisting generally of dark-colored sand underlain by

white sand. Where the saw grass or lily ponds occur there is usually a stratum of black Muck of varying depth overlying white sand.

At present this land is of no value aside from the timber it supports, the larger trees being utilized for telephone poles.

TIDAL MARSH.

Tidal marsh takes the place of the mangrove swamps from the vicinity of Viking, in St. Lucie County, on the mainland shore, and from the Bethel Creek House of Refuge on the peninsula, northward interruptedly to the limits of the survey. These marshes, like the mangrove swamps, represent low, flat, very poorly drained areas slightly above salt water and subject to salt-water inundation at times of high water from gales. They vary from narrow strips to areas a half mile or more wide or represent large areas cut by sloughs into islands. The largest body is the one at the north end of Merritts Island.

Tidal marsh constitutes the most recently formed land of the area. It is gradually being added to at the present time, encroaching upon the sounds and lagoons. The soil materials are variable, ranging from clay to sand. In the more southerly areas the material is a puttylike blue to greenish-blue or drab clay continuing to as much as 3 feet or more. It varies to drab or almost white sandy material, in places resting upon marl or limestone. On some of it there is a shallow surface layer of Muck. In places it consists of loamy sand, or sticky, sandy material, over sandy clay. On the north end of Merritts Island the material is very much like the Portsmouth fine sand, that is, a dark-gray to black loamy fine sand overlying gray or light-drab fine sand.

The extent of Tidal marsh is considerable, but it is without value, except for a little grazing. The proximity to salt or brackish waters and its inundation by salt water have brought about such a salty condition that when the surface dries crystals of salt are seen. The salt is sufficient to preclude the growth of plants other than those of a salt-tolerant character. Salt weed, salt purslane, and sword or switch grass are the characteristic plants. There are occasional clumps of black mangrove. Expensive diking would be necessary to reclaim this marsh land.

SHELL MOUNDS.

Shell mounds occur quite frequently immediately along the shore of the mainland and on the barrier island and peninsula next to the sounds or rivers. These are very small, rounded knolls to narrow, long ridges containing from a few square rods to a few acres. These mounds lie mostly 5 or 10 feet above the surrounding country, but in a few instances they rise to a height of fully 30 feet, as in the vicinity of Wabasso.

These mounds are believed to be the sites of camping places of aborigines. The shells occur in layers and there are strata in which ashes and charcoal show plainly. Further evidence of their origin is found in the presence of pieces of pottery.

Through processes of weathering there has been formed over these mounds a kind of soil mantle varying from a few inches to 15 inches in depth and consisting usually of fine sand rich in organic matter and brownish to black in color. The immediate surface where cultivated is in some places of grayish color. Sufficient organic matter is present to impart a loamy character to the soil.

These mounds support a dense hardwood jungle growth, including some large oaks. The material is being used for surfacing roads. Some patches are being cultivated principally as gardens. The material is considered productive, but crops as a rule suffer from lack of moisture during ordinary dry spells, the looseness of the underlying shells favoring rapid percolation of water.

MADELAND.

Madeland in this area constitutes tracts where soil material has been transported to fill in low places, principally to afford building sites. The largest area is that at Palm Beach, where a considerable area of original low ground, lakes, and saw-grass sloughs has been filled in not only to afford building sites but also to eliminate swampy lands with their attendant danger to health. The same operation has been undertaken at Hobe Sound, where mangrove swamp margins have been covered and building sites thus afforded. The material in both instances has been largely derived from dredging the bottom of the adjacent sounds or lagoons.

The material in these Madeland areas usually consists of a drab-colored mixture of sand, silt, and clay, with fragments of shells and marly material. After a few rains the material assumes a condition favorable to plant growth. Some good lawns have been established on the Madeland, and ornamental shrubs and flowers are grown with excellent results.

SUMMARY.

The Indian River area, Florida, is situated along the middle east coast of the Florida Peninsula. It comprises a strip of the mainland varying in width from 1 to 4 miles and the islands along the coast. The area extends from the vicinity of West Palm Beach north to Titusville, a distance of approximately 150 miles. It includes parts of Palm Beach, St. Lucie, and Brevard Counties and has an area of 341 square miles, or 218,240 acres.

The surface of the mainland varies from flat to a prominent ridge back from the shore line, and this ridge breaks off sharply to savannas

and flatwoods which extend on into the interior. The fringe of islands forming the coast is continuous, except for a few inlets. Their surface consists of a series of low ridges and intervening troughs, falling off to mangrove swamps or salt marshes along the sounds and lagoons.

The drainage is mainly effected by seepage, there being no streams beyond little seepage sloughs in the area surveyed, except the streams from the interior that cut through the coast ridge and empty into the sounds or inlets to the ocean.

The settlement of this part of the coast had hardly begun before 1850. The present population is largely concentrated in the villages and towns along the shore, the rural population being sparse. There is a large transient tourist population. The larger places are the county seats, West Palm Beach, Fort Pierce, Titusville, and in addition Cocoa, the most important shipping point for citrus fruits in the area.

The area is traversed by the Florida East Coast Railway, which affords communication both north and south between Jacksonville and Key West. There is also some water transportation on the sounds and lagoons.

A wagon road follows the coast and the railway, and except for a few small gaps in Brevard County is surfaced with either limestone, shells, or clay marl. A few branch roads lead off this main highway into the inland country wherever development is going on.

The climate is mild and salubrious. Frost rarely occurs, though freezing temperatures have been experienced in the past and have done much damage. The mean annual temperature at Merritts Island, in the northern part of the area, is 72.7° F. and at Jupiter, near the southern extremity, 73.8° F., and the winter means are 63.1° and 65.6° F., respectively.

Crops are grown throughout the year except in July, August, and September, which is known as the rainy season.

The local agriculture is one of specialized farming for the production of truck crops and fruit. The trucking is practically confined to the growing of string beans, and followed mainly in two centers on the islands along the coast in the vicinities of Quay and Jensen. The important Florida pineapple-growing district, beginning a few miles north of Fort Pierce, in St. Lucie County, and extending south to St. Lucie River and then along the St. Lucie, in Palm Beach County, lies in the area surveyed.

The growing of citrus fruits is general throughout the area. The largest groves are in Brevard County near Cocoa and on Merritts Island. Oranges and pomelos or grapefruit and some tangerines are grown commercially. The plantings of both oranges and grapefruit are being extended.

Landholdings are generally small. Along the shore the properties have a narrow frontage on the water and extend back inland some distance. Much of the land has little agricultural value. Prices are high because of the demand for building sites and the comparatively small area reclaimed. Labor is scarce, farmers being forced to pay practically the same wages as received on public works.

The soils range from cumulose deposits through sands or a mixture of sand, gravel, and shell fragments to calcareous clay. The soils fall into three groups, according to origin, viz, soils derived from cumulose deposits, from unconsolidated marine deposits, and from residual or partly residual materials of limestone origin.

The cumulose group is represented by Muck, which includes some Peat. In addition to the typical Muck, two phases are shown. Some of the hammock phase and a little of the typical Muck has been used in the production of vegetables and the former to some extent for citrus-fruit culture.

In the group of soils derived from unconsolidated marine deposits five soil series are represented, the St. Lucie, Norfolk, Palm Beach, Portsmouth, and Plummer.

The St. Lucie series constitutes the siliceous white sands found throughout the area. Two types are mapped, the St. Lucie sand and St. Lucie fine sand, the former with three phases. With the exception of the yellow subsoil phase of the St. Lucie sand and fine sand and the hammock phase of the St. Lucie sand, the soil is formed entirely of white sand and is excessively drained and of low productiveness. The only crop found suited to these soils is the pineapple, which is grown to a considerable extent in St. Lucie and Palm Beach Counties and south. The phase of St. Lucie soil, known locally as "hickory hammocks," is one of the soils used in the production of citrus fruits.

Two Norfolk soils, the sand and fine sand, are found in this area. They are high-lying, well-drained types. The Norfolk sand is of small extent and unimportant. Of the fine sand there is a considerable area. The areas of this type along the west shore of Merritts Island are devoted to the growing of citrus fruits.

Two types of the Palm Beach series are mapped, the sand and fine sand. They occur on the barrier islands just inland from the Coastal beach, and are well-drained, productive soils.

The Portsmouth series of soils is found in the poorly drained flatwoods. The sand and fine sand and a hammock phase of each are mapped. When properly drained these soils are well suited to the production of vegetables.

The Plummer sand is closely associated with the Portsmouth, occurring in the more prairielike places in the flatwoods. It is not at present used for agriculture.

The residual group of soils includes the Gainesville and Parkwood series.

The Gainesville soils are derived largely from limestone, mostly coquina, and are underlain by rock usually within the 3-foot section. Two types, the sand and loamy fine sand, were mapped. They are well-drained, productive soils and are largely used for citrus-fruit growing and to some extent for vegetables.

The Parkwood soils occur in low, poorly drained situations, mostly in the interior of Merritts Island. Limestone and marl underlie these soils and here give rise at least to the lower subsoils. Five types, the sand, fine sand, fine sandy loam, sandy loam, and clay loam were mapped. Where drained these are strong, productive soils.

Coastal beach, Swamp, Tidal marsh, Shell mounds, and Madeland are miscellaneous types, mostly nonagricultural.

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U.S. DEPT. OF AGRICULTURE
BUREAU OF SOILS
MILTON WHITNEY, CHIEF
CURTIS F. MARBUT, IN CHARGE SOIL SURVEY

SOIL MAP

FLORIDA
INDIAN RIVER SHEET

SOIL PROFILE
(3 feet deep)

St. Lucie sand — S
Parkwood sand — S, M, S, R(L)
Flat phase — S
Parkwood fine sand — Fs, Fs, R(L)
Yellow subsoil phase — S, S
Parkwood sandy loam — S, Sto, Sl, Fsc to C, R(L)
Hammock phase — S, S
Parkwood fine sandy loam — Fs, Fsto, Fsl, Fsc to C, R(L)
St. Lucie fine sand — Fs
Parkwood clay loam — Cl, C, R(L)
Yellow subsoil phase — Fs, Fs
Prairie phase — Cl, C to M, R(L)
Portsmouth sand — S, S, S(H)
Palm Beach sand — S, S
Hammock phase — S, S, S(H)
Palm Beach fine sand — Fs, Fs
Portsmouth fine sand — Fs, Fs, Fs(H)
Gainesville sand — Sto, Ls, Sto, Ls, R(L)
Hammock phase — Fs, Fs, Fs(H)
Gainesville loamy fine sand — Lfs, Lfs, R(L)
Norfolk sand — S, S
Plummer sand — S
Norfolk fine sand — Fs, Fs

LEGEND

S	Sand
Fs	Fine sand
S (H)	Sand (hardpan)
Fs (H)	Fine sand (hardpan)
M	Marl
R (L)	Rock (Limestone)
Sl	Sandy loam
Fsc	Fine sandy clay
C	Clay
Fsl	Fine sandy loam
Cl	Clay loam
Ls	Loamy sand
Lfs	Loamy fine sand

LEGEND

St. Lucie sand — Ss
Parkwood sand — Pw
Flat phase — Ss
Parkwood fine sand — Pk
Yellow subsoil phase — Ss
Parkwood sandy loam — Psl
Hammock phase — Ss
Parkwood fine sandy loam — Pfs
St. Lucie fine sand — Sf
Parkwood clay loam — Pc
Yellow subsoil phase — Sf
Prairie phase — Pc
Portsmouth sand — Po
Palm Beach sand — Ps
Hammock phase — Po
Palm Beach fine sand — Pf
Portsmouth fine sand — P
Gainesville sand — Gs
Hammock phase — P
Gainesville loamy fine sand — Gl
Norfolk sand — Ns
Plummer sand — Pl
Norfolk fine sand — Nf
Swamp — S
Muck — M
Tidal Marsh — Tm
Hammock phase — M
Shell mounds — Sm
Mangrove swamp phase — M
Madeland — Ml
Coastal Beach — Cb

CONVENTIONAL SIGNS

CULTURE
(printed in black)

City or Village, Roads, Buildings, Wharves, Jetties, Breakwater, Levee, Lighthouse, Fort.
Secondary roads and Trails
Railroads, Steam and Electric
Bridges, Ferry
R. R. crossings, Tunnel
Ford, Dam
School or Church, Cemeteries
Mine or Quarry, Mine tunnel, Made land
Bluff, Escarpment, Rock outcrop and Triangulation station
Stony and Gravelly areas
Soil boundaries, Oil wells and tanks
Boundary lines
Boundary lines
Boundary lines
U. S. township and section lines

RELIEF
(printed in brown or black)

Contours, Depression contours
Prominent Hills, Mountain Peaks
Sand, Wash, and sand dunes
Shore and Low-water line, Sandbar

DRAINAGE
(printed in blue)

Streams
Lakes, Ponds, Intermittent lakes
Intermittent streams
Springs, Canals and Ditches, Flumes
Fresh marsh, Salt marshes
Submerged marsh, Tidal flats
Salt and Fresh marsh (Fresh marsh predominating)

The above signs are in current use on the soil maps, but some may not appear in some maps of earlier dates.

Section No. 1 | Section No. 2 | Section No. 3

Hugh H. Bennett, Inspector Southern Division
Soils surveyed by Charles N. Mooney and Mark Baldwin

BASE MAP IN PART FROM U.S. COAST SURVEY CHARTS

Scale 1 inch = 1 mile

Field Operations, Bureau of Soils, 1913